STRATEGIC DEFENSE INITIATIVE ORGANIZATION (SDIO)
SMALL BUSINESS INNOVATION RESEARCH PROGRAM
Submitting Proposals

Phase I proposals (5 copies plus 3 additional copies of Appendices A and B only) should be prepared for routine U.S. mail and addressed to:

Strategic Defense Initiative Program
Attention: T/IS/SBIR
The Pentagon
Washington, D.C. 20301-7100

Since no provision will be made to receive hand-carried proposals, bidders should allow ample time for routine delivery of proposals by the U.S. Post Office. The above address can not be used for commercial delivery services or hand carry.

The SDIO SBIR Program supports science and engineering at the cutting edge of technologies that, if successful, will have a significant impact on this mission of SDI. Topic areas of special interest to SDI are described in the following paragraphs. The efforts supported will be innovations ultimately leading to a product or process that potentially can be used in strategic defense.

Many of the concepts being addressed by SDIO involve major ground or space-based systems which tax the capability of even the largest corporations. Although the total systems may be beyond the capability of a high-technology small business, many of the subsystems, components, processes, etc. fall within the scope of this solicitation. Accordingly, the prospective proposers can interpret the SDI topics in terms of how they can contribute to the solution of the broader problems and challenges described in this solicitation. In many cases, the thrust of a topic includes establishing feasibility of concepts, enabling major advancements in capability, etc. rather than production. For example, the deliverable from a successful Phase 2 effort could be a prototype which becomes an element in a demonstration program; the follow-on Phase 3 could be further research to perfect the approach following testing or evaluation.

Phase I proposals must be confined to strategic defense innovative technologies, advanced concepts, or novel approaches that in Phase 2 either may be carried out to laboratory prototype, or can lead to the next generation of products or processes. Phase 2 awards may not necessarily complete the total research and development that may be required to satisfy strategic defense needs; completion of the research and development of products or processes for use by SDI may occur during Phase 3. Ultimately, Phase 3 must address the development of products or processes for use by SDI. Ideally, the research should make a significant contribution to the solution of an important SDI problem through a product or process and provide the small business firm with the basis for a new product, process or service.

Some activities will not be funded in Phase 1 or 2: technical assistance, compilations of works of others, technology status surveys, technology assessments, development of technically proven ideas, product development, demonstration products, or pilot plants. Research and development on incremental or scaled-up versions of existing technologies may be permitted if the additional R&D is necessary to meet significantly different conditions as stated in the topic descriptions.

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SDIO88-001 TITLE: Directed Energy Concepts

DESCRIPTION: Innovative research in the generation and propagation of directed energy plays an important role in the determination of effective ballistic missile defense systems. Systems being considered include (but are not limited to) chemical lasers, excimer lasers, nuclear and non-nuclear driven x-ray lasers, gamma-ray lasers, and free electron lasers. Hybrid approaches are also of interest. Interest in the concepts include the full range of embodiment, i.e., low mass spaced-based, ground-based, and pop-up systems. Included in the directed energy problems are such diverse topics as weapon pointing, beam control, acquisition, tracking and pointing, mirror technology, beam propagation through natural and disturbed environments, and countermeasures. Approaches are needed that either extend or improve the present concepts. Approaches that facilitate or support the evaluation of concepts are also appropriate.

SDIO88-002 TITLE: Kinetic Energy Weapons

DESCRIPTION: Kinetic energy (KE) weapons systems are an integral part of candidate strategic defense systems. Near-term system candidates include ground-based exoatmospheric re-entry vehicle interceptors (ERIS) and space-based interceptors (SBI). High endoatmospheric defense interceptors (HEDI) and hypervelocity guns (HVG) [electromagnetic (EM), electrothermal (ET), and hybrid systems] both ground or space based are being considered for follow on KE systems.

Approaches are sought which extend, facilitate, support the evaluation of, or reduce the cost of the concepts. Elements of the systems include the space-based carrier vehicles (CV) or ground-based launchers, divert motors/nozzles, smart projectile components, and endo/exoatmospheric guidance and control mechanisms. Technology challenges for KE systems include: SBI acquisition of booster hardbody within the plume, high performance axial and divert population subsystems (especially very low mass divert systems), miniature inertial navigation units, array image processing, multispectral algorithms, multimode seekers, CV sensor acquisition and track of target and KKV; ERIS target designation, seeker operational environments, lethality/miss distance; HEDI aero-optical effects, computational fluid dynamic data extrapolation, guidance and fuzing accuracy, shroud separation, window thermo-structural integrity, non-nuclear kill warhead performance, target acquisition in a nuclear environment; HVG lifetime, firing rate, projectile guidance and control, and projectile launch survivability; and, common among all systems, reliability, producibility, maintainability, and low cost/low mass.

SBIR contracts have been awarded for approaches concerning the issues of HVG barrel-life, HVG projectile launch survivability, HVG efficiencies, endo-atmospheric projectile guidance and control, lethality enhancement, HVG thermal management, exoatmospheric seekers, shroud material, and low cost/low mass. Innovations in all KE system elements and issues are encouraged, but new starts in area of HVG materials (i.e., rail/insulator/armatures) are competitive at this time.

SDIO88-003 TITLE: Sensors for Surveillance, Acquisition, and Discrimination

DESCRIPTION: Sensors and their associated systems will function as the “eyes and ears” of a space-based ballistic missile defense system, providing early warning of attack, target identification, target tracking, and kill determination. New and innovative approaches to these requirements using unconventional techniques are encouraged across a broad band of the electromagnetic spectrum, from radar to gamma-rays. Passive, active, and interactive techniques for discriminating targets from decoys and other penetration aids are solicited. In addition to novel sensing concepts, sensor-related device technology is also needed, with the intended goal of producing either a specific product or process. Examples of some of the specific areas to be addressed are: cryogenic coolers (open and closed systems), superconducting focal plane detector arrays (for both the IR and sub-mm spectral regions), signal and data processing algorithms (for both conventional focal plane and interferometric imaging systems), low-power optical and sub-mm wave beam steering, range-doppler lidar and radar, passive focal plane imaging (long wavelength infrared to ultra-violet; novel information processing to maximize resolution while minimizing detector

element densities) interferometry (both passive and with active illumination), gamma-ray detection, neutron detection, intermediate power frequency agile lasers for diffractive beam steering and remote laser induced emission spectroscopy, lightweight compact efficient fixed frequency radiation sources for space-based SDI application (uv-sub-mm wave). Entirely new approaches as well as approaches that expand and improve present concepts are solicited.

SDIO88-004 TITLE: Nuclear Space Power Concepts

DESCRIPTION: Weapons, sensing, and communications systems under consideration for strategic defense have diversified power requirements. Methods and processes are being considered for a wide spectrum of power and power conditioning situations. Nuclear power concepts and the associated components are of interest for both manned and unmanned spacecraft. The power duty cycles to be considered include: hundreds of MW power for pulse applications, sustained hundreds of kW to MW power for electric propulsion, continuous tens to hundreds of kW power for house keeping, tracking, etc. This category includes auxiliary components and sub-systems vital to the operation of the power system. The energy conversion approaches include: thermoelectric, thermionic, and Brayton cycle. New approaches leading to controlled wide excursions of power and burst mode power are sought. As part of topic 7, innovative high power thermal radiator concepts are needed for all types of power cycles. Also, concepts and systems that enhance safety, maintainability, and reliability of space nuclear power systems are sought.

SDIO88-005 TITLE: Non-Nuclear Space Power and Power Conditioning

DESCRIPTION: Along the lines of topic SDIO88-004, non-nuclear approaches are sought. Applications in space demand high energy densities. The power duty cycles to be considered include: hundreds of MW power for burst applications, sustained hundreds of kW to MW power for electric propulsion, continuous tens to hundreds of kW to MW power for house keeping, tracking, etc. Specific topics include novel battery concepts, chemically driven systems for burst power, advanced solar collectors and converters, inductive and capacitive stores, space-based MHD generators, heat dissipation systems, signature control, and plasma switches. Also, concepts and systems that enhance maintainability and reliability of space power systems (e.g. insulation and cable) are sought.

SDIO88-006 TITLE: Propulsion and Logistics

DESCRIPTION: Strategic defense places unprecedented demands on all types of space transportation and propulsion systems; launch to low earth orbit, orbit transfer, orbit maneuvering, and station keeping. In particular, advancements are needed to achieve major reductions in the costs of placing and maintaining payloads in the desired orbit. Traditionally, the cost of space transportation and the operations of the spacecraft have been major factors in determining the lifecycle costs of space-based assets. This burden on the deployment of strategic defense systems has been identified a major cost driver. Approaches leading to techniques, methods, processes, and products n support of these propulsion and logistics objectives are sought.

Propulsion approaches include liquid, solid, and electric. Advancements are needed in propulsion-related areas, e.g., extending storage time of cryogenic fluids, reduction of contamination from effluents, and sensors and controls for autonomous operation. Areas of interest include the entire spectrum of space transportation and support: efficient launch systems for small technological payloads as well as full system payloads, assembly, and control systems; expendable and recoverable components; improved structures and materials; and mission incorporating arcjet thrusters, attention is being directed at thruster modules (e.g., electrodes, insulators, ignition systems, propellant control, command and control system, thermal management system, and power conditioning unit).

SDIO88-007 TITLE: Thermal Management

DESCRIPTION: The high power levels for space stations will need effective heat dissipation. Topics 87-4 and 87-5 state the power levels. Innovations are sought in thermal radiators and associated devices for all types of space-based power cycles, nuclear and non-nuclear.

SDIO88-008 TITLE: System Survivability

DESCRIPTION: The survivability of various components of a space-based missile defense system will be a key issue in the effectiveness of such a system. Products, processes, and techniques for active and passive hardening against directed and kinetic energy devices are sought. Components to be made survivable include sensors, battle management systems, power systems, and directed/kinetic energy weapon configurations. Survivable sub-components include large and small optics, electronics, structures for support and fuel containment, and specific materials critical for shielding, maneuvering, propulsion, and targeting. In addition to shielding, other well designed and innovative countermeasures are encouraged. Specific examples of areas to be addressed include thermo-mechanical shock hardening, heat dissipation techniques, protective coatings, baffling techniques, materials conditioning, orientation or deployment strategies, insulation methods, threat radiation activated optical limiters and switches, and the non-linear optical materials/techniques involved in their fabrication. Of particular interest is hardening and survivability against x-ray lasers and bright short wavelength ground-based lasers.

SDIO88-009 TITLE: Target Lethality

DESCRIPTION: A major factor in determining the effectiveness of a ballistic missile defense is the lethality of the directed and kinetic energy devices against responsively hardened targets. The key questions that need to be addressed under this topic deal with the quantitative assessment of target lethality. Hence, techniques are needed to acquire, access, and query an extensive database on the damage to basic materials, electronics, and optics due to various mechanisms. Techniques are needed to quantify laser radiation damage due to ionization, thermal deposition, and impulse shock as a function of wavelength, intensity, and pulse characteristics. This is required in order to direct future research in novel directed energy concepts. Similar techniques are needed to investigate and quantify damage mechanisms due to particle beam interaction with targets. In the area of kinetic energy, the effects of hypervelocity projectile impact on structural and hardened materials are of extreme interest. Finally, innovative ideas or concepts for measurement of radiation or particle penetration, structural damage due to thermo-mechanical stress, opacities of plasma blow-off, and equation-of-state data are relevant.

SDIO88-010 TITLE: Computer Architecture and Very High-Level Language Design for Battle Management

DESCRIPTION: Strategic defense systems for battle management demands order-of-magnitude advances. The system must acquire and track thousands of objects with hundreds of networked sensors and data processors, direct weaponry to intercept targets, and determine the degree of kill. Three areas of interest are:

- New computer architectures which are compact, fault-tolerant, and hardened to radiation, but allow for the extremely rapid processing of data that will be required. This issue can be addressed via either new designs for computer components (e.g., optical signal processors) or innovative architectures using existing technology (systalic arrays, neural networks).
- Very high-level language (VHLL) design for both the development and testing of extremely large software systems.
- Novel numerical algorithms for enhancing the speed of data processing for sensing, discrimination and system control. These may be specifically tailored to a particular system, since the computer will likely be a single-purpose design suited to the strategic defense data processing task (e.g., execution of a phase retrieval algorithm for interferometric imaging).

SDIO88-011 TITLE: Optical Computing and Optical Signal Processing

DESCRIPTION: Dense computing capability is sought in all architectural variations, from all optic to hybrid computers. Specific examples of areas to be addressed include, but are not limited to, high speed multiplexing, monolithic optoelectonic transmitters, holographic methods, reconfigurable interconnects, optoelectronic circuits, and any other technology contributing to advances in intra-computer communications, optical logic gates, bistable memories, optical transistors, and power limiters. In particular, non-linear optical materials advancements and new bistable optical device configurations are of interest.

SDIO88-012 TITLE: Space Structures

DESCRIPTION: The strategic defense mission places great demands upon the design of space structures to be used for their fabrication. The requirements include structures for prime power systems, antennas, tracking and pointing systems, solar collectors, and pressure vehicles. All of these present individual challenges in terms of stiffness, impact resistance, high temperature capability, deployment, etc. Most of the anticipated situations depend on major improvements in material properties, cost effectiveness, and prediction methodology. Space structures supporting weapons and antenna must accommodate retargeting maneuvers without detrimental jitter from vibrations wand thermo-mechanical flutter. Techniques for both passive and active control of the structural dynamic responses to environmental and operational excitations are needed. Methods are needed to predict the dynamic performance and stability characteristics of structures acting in concert with on-board distributed controllers for maneuvering, pointing, and vibration/noise suppression. There is also a need for novel, lightweight large optical structures that are compatible with the space environment, and for innovative optics/information processing techniques which maximize the imaging performance that can be achieved with imperfect, temporarily unstable structures.

SDIO88-013 TITLE: Structural Materials

DESCRIPTION: Many of the anticipated structural advances sought in Topic 87-12 will depend on major improvements in material properties, cost effectiveness, and prediction methodology. Space structures supporting weapons and antenna must accommodate retargeting maneuvers without detrimental jitter from vibrations and thermo-mechanical flutter.

Techniques are needed to obtain greatly improved understanding of structure-property relationships for advance carbon/carbon, ceramic-matrix, and metal-matrix composite materials. Specific goals requiring advanced techniques and processes include imparting oxidation resistance and damage tolerance to carbon/carbon composites, enhancing the static and dynamic toughness of ceramic composites and creating fatigue-resistant metal composites with order of magnitude improvements in passive vibrational damping. Methods are needed to address the basic mechanics of failure characteristics and fatigue behavior under complex mechanical and thermal loadings. Tribology innovative techniques and ideas are sought in areas such as solid and liquid lubricants, moving mechanical assemblies, low density alloys, and antiwear adhesives. Advances are sought in materials for optical systems, components, and radiation hardening. Proposals involving these as well as other space structure and material-related research and innovative technology topics are encouraged.

SDIO88-014 TITLE: Electronic Materials

DESCRIPTION: The necessary advances in electronics for the many strategic defense applications will require advances in electronic materials. Primary emphasis lies in advancing the capability of integrated circuits, detectors, sensors, large scale integration, radiation hardness, and all electronic components. Novel quantum-well/super lattice structures which allow the realization of unique elective properties through “band gap engineering” are sought as are new organic and polymer materials with interesting electronic characteristics. In addition, exploitation of the unique electronic properties of single crystal diamond is of considerable interest.

Among the many SDI electronic needs are advances in high frequency transistor structures, solid state lasers, optical detectors, low dielectric constant packaging materials, tailored thermal conductivity, microstructural waveguides, multilayer capacitators, metallization methods for repair of conducting paths in polyceramic sytems, and sol-gel processing for packaging materials.

SDIO88-015 TITLE: Superconductive Materials

DESCRIPTION: Recent advances in the discovery and fabrication of high-temperature superconducting materials promise to have a large pay-off for many SDI applications. Interest in these new materials includes material characterization, stabilization of new high-Tc phases, and development of novel fabrication techniques for both the thin-film and bulk materials. Areas of application are also being stressed and include: novel, low-power infrared

(IR) staring-array sensors, particularly those with monolithic focal plane pixel arrays and read-out electronics; high-Tc superconductive materials for various electronic applications, e.g., Josephson junctions and SIS mixers; bulk materials for power transmission, conditioning, and storage; compact, high-gradient accelerator cavities for novel particle beam and free-electron laser design concepts; magnetic shielding of critical components from EMP effects. Note that in the applications area interest is not limited to only this new class of high-Tc superconductors but attention is also given to the more mature low-Tc materials as well, e.g., Niobium and Niobium Nitride.

Because of the high priority given by SDIO to this new and exciting area of research and engineering, special emphasis will be given this SBIR topic in FY88.